International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; SP-9(1): 161-165

Received: 01-11-2020
Accepted: 05-12-2020

Pallavi N Bande
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India

UK Kadam
Entomologist Sorghum, Sorghum Improvement Project, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India

Radhika S Wasu
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India

RK Waykule
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India

Corresponding Author:
Pallavi N Bande
Post Graduate Student, Department of Agricultural Entomology, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India

Evaluation different pest management components against major pests of *rabi* sorghum

Pallavi N Bande, UK Kadam, Radhika S Wasu and RK Waykule

DOI: https://doi.org/10.22271/chemi.2021.v9.i1d.11558

Abstract
The field experiment was conducted during *rabi* 2018-2019 at Sorghum Improvement project, MPKV, Rahuri to asses different pest management components against major pests of *rabi* sorghum. Maximum plant population per plot was observed in plots treated with seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed. The lowest per cent of dead hearts caused due to shoot fly (11.97%) were recorded in T2 where the plots treated with seed treatment with imidacloprid 70 WS @ 3 g/kg. The lowest per cent of dead hearts caused due to stem borer (0.47%) were recorded in treatment of whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE i.e., T2. The least number of aphids were recorded in the treatment, T6: dimethoate 30% EC @ 1 ml/liter (1.48 aphid/cm^2/leaf). Effectiveness of various pest management components on the grain and fodder yield of sorghum indicated that, significantly highest grain and fodder yield (36.20 and 63.00 q/ha, respectively) was obtained from plot treated with imidacloprid 70 WS @ 3 g/kg of seed.

Keywords: Sorghum, pest management, shoot fly, stem borer, Aphids

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] is an important staple food crop of the world and 5th most important cereal crop after wheat, rice, maize and barley. In India, sorghum is popularly known as 'Jowar', or 'Great Millet'. The crop is cultivated under diverse agro ecosystem and the grain yield is influenced by various biotic and abiotic factors. The advantage of this cereal crop is that it can be cultivated in both *kharif* and *rabi* season. Sorghum is important feed and food crop in the world and used as fodder to feed millions of animals providing milk and meat for human beings. Sorghum is very nutritious its fodder contains more than 50 per cent digestible nutrients and with 8 per cent protein, 2.5 per cent fat and 45 per cent nitrogen free extract. In India sorghum is the third important cereal after rice and wheat. The total production of sorghum in India is 4.56 million tons and grown on 5.62 million hectares with productivity 812 kg/ha during (Anonymous 2016-17) [1]. In Maharashtra, sorghum is being grown on 1.39 million hectares and production is 1.75 million tons with productivity 790 kg/ha (Anonymous 2017-18) [2].
However, the production is affected by a wide array of biotic constraints, of which insect pests are major once. More than 150 species of insects have been recorded as pests of sorghum from emergence to late grain filling stage (Harris,1995) [11]. However, only nine are considered as potential and of economic importance in India. The major being shoot fly, stem borer and aphids are most important ones in sorghum growing areas of Maharashtra. Borad and Mittal (1983) [9] reported that nearly 32.2% of the grain yield was lost due to insect damage. In. India, sorghum is grouped under noncommercial group and use of synthetic pesticides by the farmers on the crops is very rare. Hence, attempt was to made to asses different pest management components against major pest of rabi sorghum.

Materials and Methods
The experiment conducted to evaluated different pest management components against major pests of *rabi* sorghum at Sorghum Improvement project, MPKV, Rahuri during 2018-2019. A trail is laid out with seven treatments using Randomized Block Design replicated thrice including farmer's practice. For this experiment "Phule Vasudha", a popular sorghum variety and "Phule Raviraj" of Sunflower was used.

The commercial sorghum variety, Phule Vasudha was planted by dibbling the seeds at a spacing of 45 x 15 cm in a plot size of 8.1 x 7.0 m, each having six rows of 7.0 m length. All the normal agronomic practices were followed. In the experimental plot, hand weeding was carried out periodically as and when required so as to keep the crop free from weeds.

The total number of plants was recorded in each treatment on 14th day after emergence of the crop. In each treatment, five sorghum plants were selected randomly and tagged for recording of insect pests at intervals. The first data was taken on 15th day after sowing and the subsequent observations were made at intervals. Shoot fly (*Atherigona soccata*) incidence was recorded in terms of dead hearts at 14th and 28th DAE, whereas for stem borer (*Chilo partellus*) dead hearts at 45th DAE was considered. Sucking pest like sorghum aphid (*Melanaphis sacchari*), was counted from tender leaves tagged plant in terms of number per plant. Later, grain yield (of sorghum and sunflower) and fodder yields were recorded, converted to quintals per hectare. Sorghum grain equivalent yield was also worked out. The data were analyzed statistically (Balikai and Bhagawat, 2009) [3].The yield data was subjected to statistical analysis. Finally an incremental cost benefit of each treatment was calculated.

Result and Discussion

Per cent plant population (12 DAE)

Plant population of each treatment was counted at 12 days after emergence (DAE) as well as recorded in per cent. Plant population in plots was ranging from 80.55 to 89.00% plants in each treatment.

The maximum plant population per plot was observed in T3 in which the sorghum seed treated with Imidacloprid 70 WS @ 3 g/kg of seed (89.00% plant population) followed by T4 (88.56%), T2 (88.12%), T1 (87.95%) and T6 (87.73%) which were at par with each other and were significantly superior over rest of the treatments. The next higher plant population observed in T5 in which plots are treated with furrow application of Carbofuran 3G @ 20 kg/ha (86.70%) while untreated plot recorded minimum plant population (80.55%) (Table 1).

Dead hearts caused by sorghum shoot fly

The data on per cent dead hearts caused by sorghum shoot fly are presented in Table 1, it could be seen from the table 1. that there was a significant difference in per cent dead hearts in the different seed treatments and plots with furrow application of insecticide than that of untreated control at 14th and 28th day after emergence.

14th day

Significantly less per cent of dead hearts (5.81%) were recorded in T1 where seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by T3 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed) (5.88%), T2 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (6.09%), T4 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (6.55%), T6 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed) (6.79%) and were at par with each other. These treatments found to be superior in reducing shoot fly damage over rest of the treatments.

The next effective treatment was T5 (furrow application of Carbofuran 3G @ 20 kg/ha) (8.72%). All these treatments were significantly superior over untreated control. Maximum dead hearts were recorded in untreated control (15.99%) (Table 1).

28th day

All the insecticidal treatments recorded significantly less per cent of dead hearts over untreated control. The lowest per cent of dead hearts (11.97%) were recorded in T2 where the seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by T1 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed)(12.45%), T6 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed)(13.67%), T3 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed) (13.85%), T4 (seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed) (14.04%) and were at par with each other. These treatments found to be superior in reducing shoot fly damage over rest of the treatments.

The next effective treatment was T5 (furrow application of Carbofuran 3G @ 20 kg/ha) (18.30%). All these treatments were significantly superior over untreated control. Maximum dead hearts were recorded in untreated control (27.97%) (Table 1).

The present findings are in line with the report of Mote (1993) [15] reported that imidacloprid 4 and 5 per cent were highly effective in reducing the dead hearts due to shoot fly.

Mote *et al.* (1995) [16] further found that seed treatment with imidacloprid 3 per cent is quite promising in checking shoot fly incidence as less dead hearts were noticed. Similar results were also reported by Sharma *et al.* (1996) [19] and Ballikai (1999) [7], they were observed that imidacloprid seed treatment was best in controlling shoot fly incidence.

Sharma Odak (1996) [18] reported that imidacloprid 70 WS seed treatment @ 7.5 g/100 g seeds was the most effective treatment for controlling shoot fly followed carbofuran 3 G @ 2 g/m row and carbosulfan 25 ST @ 20 g/100 g seeds.

Ballikai (2000) [4] reported that seed treatment with imidacloprid at 7 and 5.25 per cent giving lowest dead hearts compared with untreated control. Pande (2001) [17] reported that seed treatment with imidacloprid 70 WS @ 15 g/kg seed was most effective in reducing dead hearts of sorghum shoot fly, however seed treatment with imidacloprid 10 g/kg and thiamethoxam 70 WS @ 10 g/kg were also equally effective against this pest.

Kandalkar *et al.*, (1999) [13] tested imidacloprid 70 WS against sorghum shoot fly with a quite high single dose of 7.5 g/kg seed and found highly effective with only 0.2 and 3.99 per cent dead hearts as against 46.28 and 94.77 per cent in untreated control on 14th and 28th DAE, respectively. Those above results are in accordance with present findings.

Table 1: Effect of different pest management components on plant population and shoot Fly (*Atherigona soccata*, Rondani).

Tr. No.	Pest Management Components	Plant Population (%) (12 DAE)*	Shoot fly dead hearts (%) *	
			14 DAE	28 DAE
T-1	Seed treatment with Imidacloprid 70 WS @ 3 g/kg	87.95 (69.68)	5.81 (13.94)	12.45(20.63)
T-2	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Whorl Application of Carbofuran 3G @ 8 kg/ha at 35 DAE	88.12 (69.83)	6.09 (14.26)	11.97 (20.20)
T-3	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE + Dimethoate 30% EC @ 1 ml/liter at	89.00 (70.62)	5.88 (14.02)	13.85 21.84)

	60 DAE			
T-4	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Bt @ 20 ml/10 lit of water at 35 DAE + *Lecanicillium lecanii* @ 5g/lit at 60 DAE	88.56 (70.21)	6.55 (14.80)	14.04 (22.00)
T-5	Furrow application of Carbofuran 3G @ 20 kg/ha + Whorl Application of Carbofuran 3G @ 8 kg/ha at 35 DAE + Dimethoate 30% EC @ 1 ml/liter at 60 DAE	86.70 (68.60)	8.72 17.17)	18.30 (25.29)
T-6	Seed treatment with Imidacloprid 70 WS @ 3g/kg + Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE + Dimethoate 30% EC @ 1 ml/liter at 60 DAE + Intercrop with sunflower (4:2)	87.73 (69.48)	6.79 (15.09)	13.67 (24.44)
T-7	Untreated control.	80.55 (63.81)	15.99 (23.55)	27.97 (31.92)
	SE	0.48	0.39	0.60
	CD at 5%	1.43	1.22	1.85

DAE: Days after emergence.
*The values in parentheses indicates arcsine value.

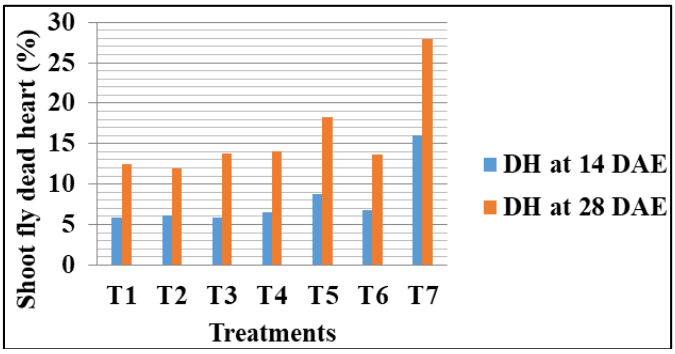

Fig 1: Effect of pest management components on dead hearts (%) caused due to shoot fly dead hearts % at 14 DAE and 28 DAE

Dead hearts caused by stem borer at 45 DAE

All the insecticidal treatments recorded significantly lowest per cent of dead hearts over untreated control. The lowest per cent of dead hearts (0.47%) were recorded in T2 where the plots treated with whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE followed by T5: whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE.(0.52%), T4: foliar spray of Bt @ 20 ml/10 lit of water at 35 DAE(0.64%) and were at par with each other. These treatments found to be superior in reducing stem borer damage over rest of the treatments. The next effective treatment was T3: foliar spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE (2.89%) followed by T6: foliar spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE (3.02%) and were at par with each other.

The other effective treatment was T1: seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (4.71%). All these treatments were significantly superior over untreated control. Maximum dead hearts were recorded in untreated control (5.19%) (Table 2.).

Jose *et al.*, (1996)[12] reported that *Bacillus thuringiensis* (1 g/litre), NSKE (5%), nimbecidine (5ml/litre) and *Metarhizium anisopliae* (1g/litre) were the most effective biopesticides in reducing stem borer damage.

Sharma and Odak (1996)[18] reported *B. thuringiensis* applied alone as more effective than endosulfan in reducing damage due to stem borer incidence.

Aphid population/cm^2/leaf

Study of different pest management components against aphid on 67 days after sowing revealed that significant difference between the treatments. The least number of aphids were recorded in the treatment, T6: Dimethoate 30% EC @ 1 ml/liter (1.48 aphid/cm^2/leaf) followed by T3: Dimethoate 30% EC @ 1 ml/liter (1.63 aphid/cm^2/leaf), T5: Dimethoate 30% EC @ 1 ml/liter (1.74 aphid/cm^2/leaf) and were at par with each other. These treatments found to be superior in reducing aphid population/cm^2/leaf over rest of the treatments. The next effective treatment was T4: foliar spray of *Lecanicillium lecanii* @ 5g/liter at 60 DAE (7.23 aphid/cm^2/leaf) while T1: Seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed. (52.00 aphid/cm^2/leaf) and T2: Seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (53.20 aphid/cm^2/leaf)were at par with each other.The highest population (53.50 aphid/cm^2/leaf) was recorded in the control plot (Table 2). The present studies are in close agreement with Balikai and Lingappa (2003) [6] reported that Dimethoate 30 EC @ 1.7 ml/l recorded 95.25 per cent reduction in aphid population at 10 days after spraying in sorghum cultivar, M 35-1 followed by Chlorpyriphos (91.13%). Daware et al. (2011) [10] studied the bio efficacy of thiamethoxam 25 WG, Imidacloprid 17.8 SL, Dimethoate 30 EC and biopesticides, NSKE 5%, nimark and karanja leaf extract 5% against sorghum aphid and found that all insecticides were significantly superior in controlling sorghum aphid.

Yield (q/ha)

Grain yield

It could be seen from Table 2. that significantly highest grain yield was obtained in the plot treated with seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE and spray of Dimethoate 30% EC @ 1 ml/liter at 60 DAE (36.20 q/ha) i.e. T3 which was superior over rest of the treatments. The next best treatment was T4: seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by spray of Bt @ 20 ml/10 lit of water at 35 DAE and *Lecanicillium lecanii* at 60 DAE (35.41 q/ha) and T3 as well as T4 were at par with each other.

While T5: furrow application of Carbofuran 3G @ 20 kg/ha followed by whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE and foliar spray of Dimethoate 30% EC @ 1 ml/liter at 60 DAE (29.40 q/ha) as well as T2: Seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE (27.70 q/ha) were at par with each other.

The treatments in there descending order of grain yield were T1: seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (24.00 q/ha), T6: seed treatment with Imidacloprid 70 WS @ 3g/kg of seed followed by spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE and Dimethoate 30% EC @ 1 ml/liter at 60 DAE + Intercrop with sunflower (4:2) (23.18 q/ha). Here T1 and T6 were at par with each other. All these treatments were significantly superior over untreated control (20.60 q/ha).

Fodder yield

The fodder yields in different pest management component treatments are presented in Table 2. All the treatments

recorded significantly higher fodder yield over untreated control. The highest fodder yield was obtained in the plot treated with seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE and spray of Dimethoate 30% EC @ 1 ml/liter at 60 DAE (63.00 q/ha) i.e. T3 which was superior over rest of the treatments. Followed by T4: seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by spray of Bt @ 20 ml/10 lit of water at 35 DAE and *Lecanicillium lecanii* at 60 DAE (61.20 q/ha) and were at par with each other. The rest of the treatments were also recorded higher fodder yield over untreated control (33.33 q/ha).

The treatments in there descending order of fodder yield were, T5: furrow application of Carbofuran 3G @ 20 kg/ha followed by whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE and foliar spray of Dimethoate 30% EC @ 1 ml/liter at 60 DAE (56.30 q/ha), T2: Seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed followed by whorl application of Carbofuran 3G @ 8 kg/ha at 35 DAE. (50.10 q/ha), T1: seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed (40.90 q/ha), T6: seed treatment with Imidacloprid 70 WS @ 3g/kg of seed followed by spray of Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE and Dimethoate 30% EC @ 1 ml/liter at 60 DAE + Intercrop with sunflower (4:2) (37.10 q/ha). Here only T1 and T6 were at par with each other.

The results obtain from present investigation are in line with Kudale (2002) [14] who reported maximum grain yield of sorghum with imidacloprid seed treatment. Balikai (2004)[5] reported highest grain yield was recorded in the plots treatedwith dimethoate 30EC @0.05% (28.9 q/ha).

Bhanukiran and Panwar (2005) [8] reported that, *Bt kurstaki* and neem formulations as the next best treatments after endosulfan with respect to yield.

Daware *et al.*, (2011) [10] reported significantly maximum grain yield with thiamethoxam @ 3.1 g a.i/kg and imidacloprid @ 8.75 g a.i./kg seed treatment.

Sonalkar. (2018) [20] found seed treatment with imidacloprid 70 WS @ 10 ml/kg seed followed by quinalphos 25% EC spray @ 20 ml/10 lit water 15 days after emergence significantly most effective, for getting higher grain yield and incremental cost benefit.

Table 2: Effect of different pest management components on stem borer, (*Chilo partellus* Swinhoe), aphid *Melanaphis sacchari* and yield of sorghum.

Tr. No.	Pest Management Components	Stem borer dead hearts (%) at 45 DAE*	Aphid population/ cm²/leaf **	Yield (q/ha)	
				Grain	Fodder
T-1	Seed treatment with Imidacloprid 70 WS @ 3 g/kg of seed.	4.71 (12.64)	52.00 (7.24)	24.00	40.90
T-2	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Whorl Application of Carbofuran 3G @ 8 kg/ha at 35 DAE.	0.47 (3.91)	53.30 (7.34)	27.70	50.10
T-3	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Azadirachtin 1% EC@ 2.5 ml/lit at 35 DAE + Dimethoate 30% EC @ 1 ml/lit at 60 DAE.	2.89 (9.76)	1.63 (1.46)	36.20	63.00
T-4	Seed treatment with Imidacloprid 70 WS @ 3 g/kg + Bt @ 20 ml/10 lit of water at 35 DAE + *Lecanicillium lecanii* @ 5g/lit at 60 DAE.	0.64 (4.57)	7.23 (2.78)	35.41	61.20
T-5	Furrow application of Carbofuran 3G @ 20 kg/ha + Whorl Application of Carbofuran 3G @ 8 kg/ha at 35 DAE + Dimethoate 30% EC @ 1 ml/liter at 60 DAE.	0.52 (4.11)	1.74 (1.50)	29.40	56.30
T-6	Seed treatment with Imidacloprid 70 WS @ 3g/kg & Azadirachtin 1% EC @ 2.5 ml/lit at 35 DAE and Dimethoate 30% EC @ 1 ml/liter at 60 DAE + Intercrop with sunflower (4:2).	3.02 (10.00)	1.48 (1.41)	23.18	37.10
T-7	Untreated control.	5.19 (13.16)	53.50 (7.35)	20.60	33.33.
	SE	0.22	0.06	1.42	1.66
	CD at 5%	0.68	0.18	4.43	5.17

DAE: Days after emergence

*The values in parentheses indicates arcsine value.

**The values in parentheses indicate $\sqrt{n+0.5}$ value.

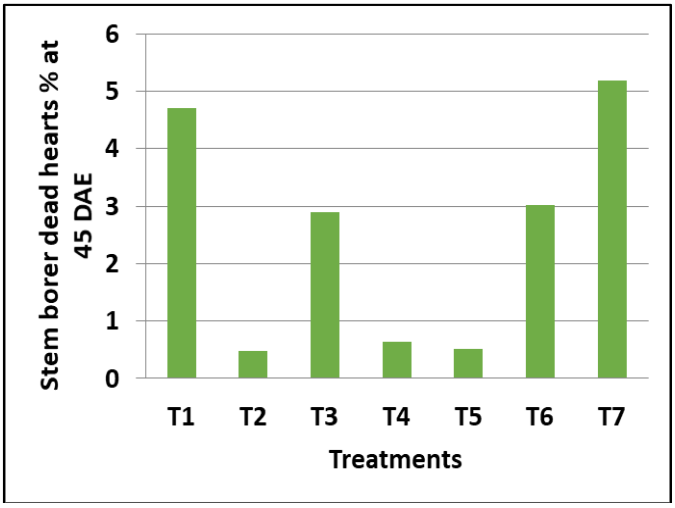

Fig 2: Effect of pest management components on dead hearts (%) caused due to stem borer at 45 DAE

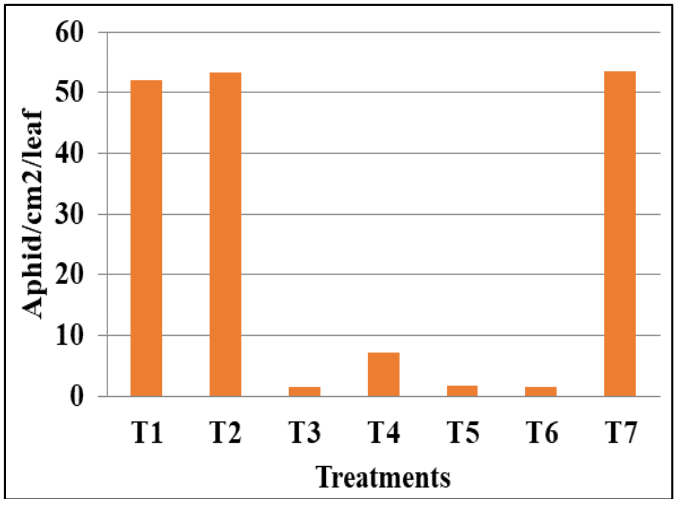

Fig 3: Effect of pest management components on Aphid population/cm2/leaf

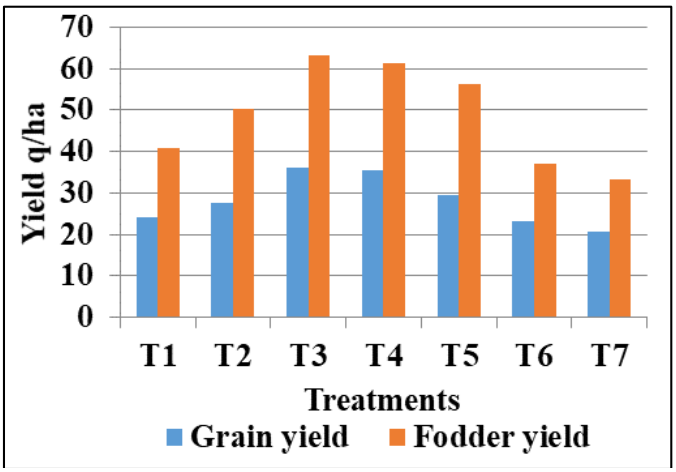

Fig 4: Effect of pest management components on grain yield and fodder yield

References

1. Anonymous. India Agristat.com, Productivity and production of Jowar in India 2017-2018.
2. Anonymous. krishi.maharashtra.gov.in, Fourth advance estimates of area, production & productivity of crops in respect of Maharashtra state for the year 2017-18.
3. Balikai RA, Bhagwat VR. Evaluation of integrated pest management components for the management of shoot fly, shoot bug and aphid in *rabi* sorghum. Karnataka Journal of Agricultural Sciences 2009;22(3-spl.issue):532-534.
4. Balikai RA. Bioefficacy of imidacloprid 70 WS against sorghum shoot fly in rabi season. Research on crops 2000;1(2):192-195.
5. Balikai RA. Chemical control of Sugarcane leaf aphid, *Melanaphis sacchari* (Zehntner) on *Rabi* Sorghum. Agric. Sci. Digest 2004;24(2):142-144.
6. Balikai RA, Lingappa S. Chemical control of aphid, *Melanaphis sacchari* in rabi sorghum, Ent. Res. 2003;27(2):121-126.
7. Balikai RA, Kullaiswamy BY, Biradar BD. Development of new sorghum lines for shoot fly resistance. Insect Environ 1999;5(2):64.
8. Bhanukiran V, Panwar VPS. Bioefficacy of neem products and insecticides against maize stalk borer, Chilo partellus (Swinhoe). Indian J. Ent 2005;67:24-28.
9. Borad PK, Mittal VP. Assessment of losses caused by pest complex to sorghum hybrid CSH-5. In proceedings, Crop losses due to insect pests (eds. Krishnamurthy Rao B. H. and K.S.R.K. Murthy). Rajendranagar. Hyderabad, India: Entomological Society of India 1983, pp. 271-228.
10. Daware DG, Ambilwade PP, Kambale RJ, Bhosale BB. Bioefficacy of insecticide and biopesticides against sorghum aphid, Melanaphis sacchari (Zehntner).Indian J. Ent 2011;73(2):97-99.
11. Harris KM. World review of recent research on panicle insect pests of sorghum and pearl millet. In: Panicle insects of sorghum and pearl millet: Proceedings of an International Consultative Workshop, 4-7 October 1993, ICRISAT Sahelian Center, Niamey, Niger 1995, Pp. 7-25.
12. Jose Deepthi, Shekharappa, Patil RK, Evaluation of biorational pesticides for the management of stem borer, Chilo partellus Swinhoe in sweet sorghum. Karnataka J. Agric. Sci 2008;21(2):293-294.
13. Kandalkar HG, Men UB, Atale SB, Kadam PS. Effect of meteorological factors on incidence of sorghum stem borer, chilo partellus Swin. J Appl. Zool. Res 2002;13:69-70.
14. Kudale NV. Evaluation of new systemic insecticides *Atherigona soccata* and *Chilo partellus (Swinhoe)* on sorghum. M.Sc. (Agri.) Thesis, Dr.Pdkv, Akola, M.S. India 2002.
15. Mote UN, Jadhav SS. Seasonal occurrence of flea beetles, delphacids, leaf sugary exudation and aphids on rabi sorghum. J Maharashtra Agric. Univ 1993;18:133-134.
16. Mote UN, Mohite AP, Lolage GR. Effect of imidacloprid as seed dresser and foliar spray against sorghum shoot fly. Pestology 1995;19(5):24-28.
17. Pande NG. Management of sorghum shoot flywith the seed treatment of some insecticides. M.Sc.(Agri.) Thesis, Dr. PDKV, Akola, M. S., India 2001.
18. Sharma ML, Odak SC. Efficacy of *Bacillus thuringiensis* separately and in combination with chemical insecticide against sorghum stem borer. Indian J. Ent., 1996;58:354-358.
19. Sharma Manorama, Kapoor KN, Bharaj GS. Effect of seed treatment of sorghum with some new insecticides for control of shoot fly. Crop Res 1996;11(1):90-92.
20. Sonalkar VU, Pagire KS. Reaction of Grain Sorghum Varieties to Major Pests in Vidarbha Region Int. J. Curr. Microbiol. App. Sci 2017;6(2):891-898.